National Aeronautics and Space Administration

goddard technology

Cryo-Propellant Storage

Applying Cryogenic Know-How to Human Spaceflight

About the Technology

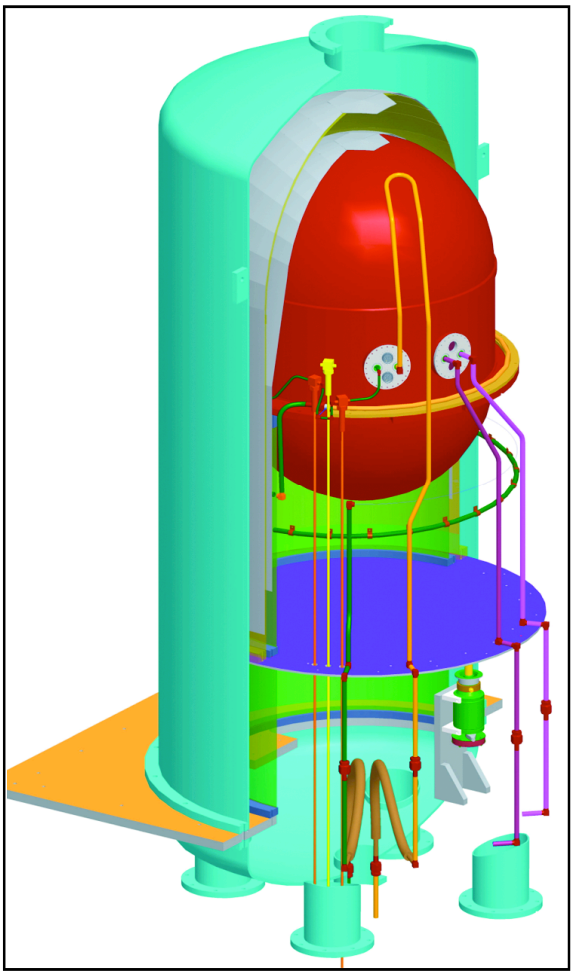
Goddard's Cryogenic and Fluids Branch is leveraging its unique experience with long-life and dual-cryogen systems to develop a subscale cryo-propellant tank system that demonstrates many of the technologies needed for the long-term storage of cryogenic fuels in space — a capability NASA will need to power its Constellation suite of vehicles and ultimately increase the payload capacity of its transportation system.

Significance of the Technology

Cryogenic propellants, such as liquid oxygen and liquid hydrogen, have been used to fuel launch vehicles or orbital-insertion stages for more than 50 years. That is because a greater fraction of a vehicle's initial mass can be devoted to payload. Analyses show, for example, that NASA would realize a 1.3-ton mass advantage if it fueled the Orion Crew and Service Module with liquid hydrogen and oxygen.

Currently, however, their use is confined to launch vehicles where hold times are minimal. This is because cryogenic fuels boil off unless properly insulated. While engineers have developed technologies to prevent boil-off in small scientific payloads, they have not scaled up their designs to the size required for large-vehicle propulsion systems.

The aim of the Goddard development effort is to demonstrate technologies, including efficient zero-gravity venting and conductive heat-interception systems, which NASA would need for large, extremely low boil-off propellant tanks in space. Through design studies, it also aims to show where cryogenic technology can provide additional benefit to the Constellation program, including its Orion Service Module and lunar rover power system.



This is an artist's rendering of the fuel-storage system Goddard technologists are developing to protect cryogenics from boil-off.

See reverse side

Cryo

Benefits of the Technology: At-A-Glance

- Developed a set of scaling laws for optimal tank-support structures.
- Demonstrated that a liquid hydrogen and liquid oxygen propellant system can fit in the service-module envelope.
- Shown that a liquid oxygen/cold gaseous hydrogen system minimizes the overall mass for a lunar rover regenerative fuel-cell power system.
- Developed a set of design rules for tank-support heat exchangers.

Technology Origins

Goddard has extensive expertise in stored cryogen systems for ground and space applications, having either developed or consulted on virtually every cryogenic scientific payload developed by NASA. The Center's Cryogenic and Fluids Branch believes it can leverage that expertise to develop much larger tanks to store large liquid hydrogen and oxygen tanks, using the knowledge it gained from its Superfluid Helium On-Orbit Transfer (SHOOT) shuttle demonstration. That experiment answered many questions about the behavior of superfluid helium in a microgravity environment and now serves as a starting point for some of the technology development needed to store cryo-propellants in space.

The Cosmic Background Explorer used Goddard-developed cryogenic dewars to keep its sensitive instruments cold.

Looking Ahead

Work on the subscale tank system will continue under an FY08 Internal Research and Development program. After the team completes the assembly of the original system, it will install and test an advanced heat exchanger. In parallel, a stiff, lightweight carbon-composite thermal shield made from special high-conductivity fiber will be developed to replace the original aluminum shield.

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